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New decapod crustaceans from the Cenomanian (Upper Cretaceous) of Lebanon

Riassunto – Nuovi crostacei decapodi del Cenomaniano (Cretaceo superiore) del Libano.

In questo lavoro, che arricchisce le conoscenze sulla fauna carcinologica del Cenomaniano (Cretaceo superiore) del Libano, viene descritto un piccolo campione di crostacei decapodi, rinvenuti nei giacimenti di Hakel e Hadjula. Lo studio di questo campione ha portato alla descrizione di *Phoenice pastini* n.gen.n.sp. (infraordine Stenopodidea Bate, 1888, famiglia Stenopodidae Claus, 1872), di *Glyphea damest* n.sp. (infraordine Palinura Latreille, 1803, famiglia Glypheidae Zittel, 1885), di *Jasus* Parker, 1883 con *J.* sp. (infraordine Palinura Latreille, 1803, famiglia Palinuridae Latreille, 1802) e di *Callianassa* Leach, 1814 con *C.* sp. (infraordine Anomura H. Milne-Edwards, 1832, famiglia Callianassidae Dana, 1852). *Phoenice* n.gen. rappresenta il più antico genere di stenopodide finora conosciuto e *Jasus* Parker, 1883 rappresenta la più antica testimonianza di questo genere, conosciuto finora solo nell'Oligocene della Nuova Zelanda.

Parole chiave: Crostacei, Decapodi, Cretaceo superiore, Libano.

Abstract – In this work that deepens the knowledge about the carcinologic fauna of the Cenomanian (Upper Cretaceous) of Lebanon, a small sample of decapod crustaceans, discovered in the Hakel and Hadjula outcrops, is described. The study of this sample has allowed the description of *Phoenice pastini* n.gen.n.sp. (infraorder Stenopodidea Bate, 1888, family Stenopodidae Claus, 1872), *Glyphea damest* n.sp. (infraorder Palinura Latreille, 1803, family Glypheidae Zittel, 1885), *Jasus* Parker, 1883 with *J.* sp. (infraorder Palinura Latreille, 1803, family Palinuridae Latreille, 1802) and *Callianassa* Leach, 1814 with *C.* sp. (infraorder Anomura H. Milne-Edwards, 1832, family Callianassidae Dana, 1852). *Phoenice* n.gen. represents the oldest genus of the infraorder Stenopodidea Bate, 1888 known to date, while *Jasus* Parker, 1883 represents the oldest report of this genus in the fossil record, known up to now only in the Oligocene of New Zealand.

Key words: Crustacea, Decapoda, Upper Cretaceous, Lebanon.

History of the research on the decapod crustaceans of Lebanon

Although bibliographic sources ascribe the first report of fossil fishes in Lebanon to Herodotus (450 B.C.), the most ancient written evidence dates back to the Middle Ages. In a manuscript dated 1248, published later in 1547, Sire de Joinville mentioned the discovery of fossil fishes: "*Tandis que le Roy estoit à Sayette, le rapporta l'en une pierre qui se levoit par escales, la plus merveilleuse*

du monde; car quand l'en trouvoit entre les deux pierres la forme d'un poisson de mer. De pierre estoit le poisson: mais il ne failloit riens en sa fourme, ne yex, ne areste, ne couleur, ne autre chose que il ne feust autre tel, comme s'il feust vif. Le Roy manda une pierre, et trouva une tanche dedans, de brune couleur et de tele façon comme tanche doit estre”.

After this first evidence, about five centuries passed before the fossils of Lebanon started rising a scientific interest. The palaeontological researches were directed above all to the ichthyofauna and secondly to the invertebrates.

The work “Note sur une nouvelle espèce de Crustacé fossile (*Penaeus libanensis*)” by Brocchi (1875) was the first paper on the fossil decapod crustaceans from Lebanon. The author described a well preserved specimen of Sahel Alma on which he based the new species *Penaeus libanensis*. Three years later, Fraas (1878) described the new species *Pseudastacus hakelensis*. The first most extensive paper on Lebanese decapod crustaceans was written by Dames (1886). The six specimens, from Sahel Alma and Hakel, were ascribed by Dames as follows: one to the new species *Penaeus septemspinatus*, two to the species described by Brocchi, a fragment to the new species *Ibacus praecursor* and two to the species *Pseudastacus hakelensis* Fraas, 1878. The decapod crustaceans only drew attention again some 60 years later. The basis for this renewed interest was the collection belonging to the Natural History Museum of London, made between 1930 and 1931: it included 120 specimens from Hakel, Hadjula and Sahel Alma. Glaessner (1945) analyzed this collection, which allowed him first of all to revise the species previously described by Brocchi and Dames and then to describe new genera and species.

Almost at the same time Roger (1946) studied a rich invertebrate collection from Hakel, Hadjula and Sahel Alma, housed in Paris, at the Muséum National d'Histoire Naturelle and at the Ecoles des Mines. The author ascribed the decapod crustaceans (around 30 specimens) partly to established species like *Penaeus libanensis* Brocchi, 1875, *Penaeus septemspinatus* Dames, 1886, and *Pseudastacus hakelensis* Fraas, 1878, and partly to new genera. The studies by Glaessner and Roger were printed independently. Hence some of the species described by Roger are undoubtedly species described by Glaessner, which have priority since they were published one year before.

In 1974 G. Pinna of the Museo di Storia Naturale di Milano visited the Lebanese fossiliferous levels, collecting 26 specimens of decapod crustaceans presently housed at the Museo di Storia Naturale di Milano. Brugnoli Gioffredi *et al.* (1975) assigned the specimens to *Acanthochirana cenomanica* Glaessner, 1945, *Carpopenaeus callirostris* Glaessner, 1945, *Homarus hakelensis* (Fraas, 1878), and *Pseudastacus dubertreti* Roger, 1946.

Förster (1984) ascribed six specimens to the new genus *Palibacus* (family Scyllaridae Latreille, 1825) with the species *Palibacus praecursor* (Dames, 1886).

The most recent study on Lebanese decapod crustaceans was published by Garassino (1994), describing new genera and revising some other genera.

Geological age of the outcrops

The fossiliferous sites from which the studied sample originates are located NE of Beirut, on the ridges running parallel to the coast, where the Upper Cretaceous strata crop out. The Hakel and Hadjula outcrops are about 12 km from the sea and 45 km from Beirut.

The assessment of the age of the two fossiliferous sites dates back quite a few years.

Botta (1833) dealt with the age of Hakel, Hadjula and Sahel Alma, assuming that the first was younger than the second. He wrote: "*Les gisement de ces poissons (Hakel), lui est supérieur; l'autre (Sahel Alma) se trouvant plus rapproché du terrain sablonneux*".

In order to establish the stratigraphical position of Hakel, Lartet (1869) used fossil evidence: "*Parmi les Poissons, les Téléostéens abondent, tant que les Ganoides font complètement défaut, ce qui montrerait, à défaut d'autre preuve que ce n'est pas une faune jurassique. On y trouve des genres vivants tels que Beryx, les Clupes etc et des groupes caractéristiques de l'époque crétacée comme les Dercetis et le Eurypholis*".

The first author to deal with the geology of Lebanon was Fraas (1878), who incorrectly ascribed the Hakel and Hadjula outcrops to the Turonian. During the first years of the twentieth century Douvillé (1910), in collaboration with Zumoffen, suggested a Cenomanian age for Hadjula. With the "Traité de Géologie" by Blankenhorn (1914) and the classical work on the geology of Lebanon by Zumoffen (1926), the real geological study of Lebanese outcrops started. Dubertret & Vautrin (1937) referred Hakel and Hadjula to the Cenomanian. More detailed information on the geology of the area were supplied by the studies of Dubertret (1959, 1966). New geological studies carried out by Hüekel (1970, 1974) placed these two deposits at the Lower-Middle Cenomanian boundary, pointing out, however, that Hadjula was slightly older than Hakel. The biostratigraphical study of the Lebanese outcrops by Saint-Marc (1974) confirmed Hüekel's conclusion.

Modes of preservation and material

The fossiliferous rock at Hakel and Hadjula consists of thick layers of yellow limestone with a sublithographic appearance. The crustaceans are compressed and flattened on the surface of the rock and their preparation is made easy by the softness of the rock. The good state of preservation of the specimens allowed a detailed reconstruction of the anatomy of some species.

The studied sample (4 specimens in all) belongs to the collection of the Museo di Storia Naturale di Milano (MSNM) and includes: one specimen ascribed to *Phoenice pasinii* n.gen.n.sp. (infraorder Stenopodidea Bate, 1888, family Stenopodidae Claus, 1872), one specimen ascribed to *Glyphea damesi* n.sp. (infraorder Palinura Latreille, 1803, family Glypheidae Zittel, 1885), one specimen to *Jasus* Parker, 1883 with *J.* sp. (infraorder Palinura Latreille, 1803, family Palinuridae Latreille, 1802) and one specimen to *Callianassa* Leach, 1814 with *C.* sp. (infraorder Anomura H. Milne-Edwards, 1832, family Callianassidae Dana, 1852).

Acronym, MSNM: Museo di Storia Naturale di Milano

Systematics

Infraorder Stenopodidea Claus, 1872

Family Stenopodidae Claus, 1872

Genus *Phoenice* nov.

Diagnosis: subrectangular carapace with well-marked cervical and branchiocardiac grooves; long rostrum with four/five suprarostal teeth; chelae of pereopod III with upper and lower margin entire; telson elongate and lance-shaped; endopodite of the uropods with two longitudinal dorsal ridges.

Derivatio nominis: from the latin word *Phoenice, es* = Fenicia, ancient name of Lebanon.

Type species: *Phoenice pasinii* n.sp.

Description: as for the type species.

Phoenice pasinii n.sp.

Figs. 1, 2

Derivatio nominis: dedicated to Mr. Gianni Pasini, friend and amateur palaeontologist.

Holotype: MSNM i24799.

Type locality: Hakel.

Geological age: Cenomanian.

Diagnosis: as for the genus.

Material: one complete and fairly well preserved specimen, in part and counterpart.

Description. Large elongate stenopodid, with thin, completely smooth exoskeleton and 15 cm in length.

Carapace. In lateral view, the carapace is subrectangular in outline and narrows slightly anteriorly due to the weak curvature of the ventral margin. The dorsal midline is straight and the posterior margin is strongly sinuous, with a marked concavity in the lower third, covering part of somite I, and strengthened by a thin margin carina. The dorsal midline extends into a long rostrum, curving upwards distally and bearing four or five identical anteriorly projecting suprarostal teeth. There are no subrostral teeth. The ocular incision is narrow and shallow, with weakly developed antennal and pterygostomial angles. Well-marked cervical and branchiocardiac grooves are visible on the surface of the carapace. No carinae or spines are evident.

Abdomen. The somites are rectangular in outline and somite VI is shorter than those anterior to it. The pleurae are rounded and the posterior margin is slightly sinuous. The telson is elongate and lance-shaped. The uropods are about 1/3 longer than the telson. The exopodite lacks the diaeresis, while the endopodite shows two longitudinal dorsal ridges.

Cephalic appendages. The eye-stalk is long and slender. The antennular peduncle comprises three segments: the 1st thin and strongly elongate, the 2nd long and thin and the 3rd short and stocky. The scaphocerite is strongly elongate, with a pointed distal extremity. The carapocerite is short and bears a flagellum as long as the body.

Thoracic appendages. The 3rd maxilliped has thin and elongate articula,

bearing a row of small-sized spines along the margins. Pereiopods I-II have thin and elongate merus and carpus and short thin chelae. Pereiopod III is strongly elongate, bearing elongate chelae with upper and lower margin entire. Pereiopods IV-V consist of thin and elongate articula, with a terminal dactylus.

Abdominal appendages. The pleopods have a subrectangular sympodite bearing two long multiarticulate flagella.



Fig. 1 – *Phoenice pasinii* n.gen.n.sp., reconstruction.

Observations

This specimen shows some morphological features - such as the well developed cervical and branchiocardiac grooves, the absence of diaeresis on the exopodite and above all the pereiopod III longer than pereiopods I-II - typical of the infraorder Stenopodidea Bate, 1888 (Holthuis, 1993).

Schram (2000) has recently described the new genus *Jilinocaris*, the first fossil record of stenopodid crustacean in the Upper Cretaceous (Santonian) of China, ascribing it to the family Spongicolidae Schram, 1986. The comparison between the Lebanese specimen and the Chinese genus is very difficult for the

bad state of preservation of *Jilinocaris* Schram, 2000. However, I justify the institution of *Phoenice* n.gen. for some features, such as the long rostrum with suprarostrals teeth and the well developed cervical and branchiocardiac grooves, different than those observable in *Jilinocaris* Schram, 2000. On the ground of this observation, *Phoenice* n.gen. therefore represents the oldest genus of the infraorder Stenopodidea Bate, 1888 known to date.

The perfect state of preservation of the Lebanese specimen has allowed its ascription to a known stenopodidean family. As Holthuis (1993) points out, the infraorder Stenopodidea Bate, 1888 includes two living families, Spongicolidae Schram, 1986 and Stenopodidae Claus, 1872. The main features that allow to distinguish these families are the subquadrangular (Spongicolidae) or subtriangular (Stenopodidae) telson and the presence of one (Spongicolidae) or two (Stenopodidae) longitudinal dorsal carinae on the endopodite of the uropods. The presence of two longitudinal dorsal carinae on the endopodite of the uropods and the subtriangular telson allow to ascribe *Phoenice* n.gen. to the family Stenopodidae Claus, 1872.

Infraorder Astacidea Latreille, 1802

Family Glypheidae Zittel, 1885

Genus *Glyphea* von Meyer, 1853

Glyphea damesi n.sp.

Fig. 3

Diagnosis: strongly tuberculate subcylindrical carapace; short rostrum lacking supra- and subrostral teeth; two tuberculate longitudinal carinae in the gastric region; deep and sinuous cervical groove, joining to the hepatic and antennal grooves in the pterigostomial region; postcervical groove creating an acute angle before joining to the branchiocardiac groove; pereopod I subchelate and with a very elongate propodus.

Derivatio nominis: dedicated to W. Dames, one of the first palaeontologists who studied the decapod crustacean assemblage of the Lebanese outcrops.

Holotype: MSNM i25122.

Type locality: Hadjula.

Geological age: Cenomanian.

Material: one specimen in a good state of preservation.

MSNM i25122.

Description. A small-sized glypheid with strong and very tuberculate carapace, 4 cm in length.

Carapace. The carapace, in lateral view, is subcylindrical in outline, with the ventral margin rising considerably in the anterior third. The dorsal margin is straight and bends slightly near the cervical groove. The dorsal margin extends into a short rostrum, lacking both supra- and subrostral teeth. The posterior margin is sinuous with a slight convexity in the median and lower parts and is strengthened by a strong marginal ridge. The ocular incision is narrow and shallow and the antennal and pterigostomial angles are weakly developed. The cervical groove, originating in the median part of the dorsal margin, is wide and very deep and joins the weak antennal groove. The branchiocardiac groove is

sinuous and it starts from the posterior third of the dorsal margin. The postcervical groove also originates in the posterior third of the dorsal margin and it creates an acute angle with the branchiocardiac groove. It anteriorly bends downward and joins the anterior extremity of the branchiocardiac groove, thus delimiting an elongate triangular lobe. The deep ventral groove starts from the anterior extremity of the branchiocardiac groove. In the gastric region there are two very tuberculate strong longitudinal carinae, running along the whole region.

Abdomen. The somites are subrectangular in outline and have the same length. A thin transversal groove runs in the median part of the pleurae of somites I-V. The telson is subrectangular in outline and does not show a characteristic ornamentation. The uropods are badly preserved. It is possible to observe only a median longitudinal carina running along the exopodite.

Cephalic appendages. The cephalic appendages are not preserved.

Thoracic appendages. The well developed 3rd maxilliped consists of four spine articula narrowing slightly toward the distal extremity. The subchelate pereopod I has a very elongate propodus, crossed by two tuberculate longitudinal carinae. The shape of dactylus is particularly interesting: the inner margin has a strong spine originating at the base of the dactylus, while the outer margin has two spines. The outer margin of the merus of pereopod I shows a row of small-sized spines. Pereiopods II-V are badly preserved and are impossible to describe.

Abdominal appendages. The abdominal appendages are not preserved.

Observations

Four genera belong to the family Glypheidae Zittel, 1885: *Glyphea* von Meyer, 1835, *Litogaster* von Meyer, 1847, *Paralitogaster* Glaessner, 1969 (substitution name for *Aspidogaster* Assmann, 1927; cfr. Förster, 1967), and *Triasiglyphea* Van Straelen, 1936.

Woods (1925) highlights the main features of *Glyphea* von Meyer, 1835: strongly tuberculate subcylindrical carapace; short rostrum lacking supra- and subrostral teeth; two or three tuberculate longitudinal carinae in the gastric region; deep and sinuous cervical groove, joining the hepatic and antennal grooves in the pterigostomial region; branchiocardiac groove; postcervical groove creating an acute angle before joining the branchiocardiac groove; pereopod I subchelate; pereiopods II-V with terminal dactylus; exopodite with diaeresis.

The main features of *Glyphea* von Meyer, 1835 can be observed in the examined specimen.

Thanks to several works (Wöhrmann & Koren, 1862; Van Straelen, 1925; Woods, 1925; Beurlen, 1933; Kuhn, 1952; Woods, 1957; Feldmann & McPherson, 1980; Feldmann, 1981; Damborenea & Mancenido, 1987; Feldmann et al., 1993; Garassino, 1996, 1997, 2000; Garassino et al., 1996; Feldmann & Gaździcki, 1997) we presently know about 50 species ascribed to this genus, distributed from the Carnian (Upper Triassic) to the Bartonian (Eocene).

I wish to point out that this genus has never been subject to a careful review; it is therefore possible that many species are synonymous on the basis of certain features, such as the path of the grooves, the number of carinae on the gastric region of the carapace and the first pair of pereiopods.

At present, eight species of *Glyphea* Zittel, 1885 are known in the Cretaceous, from the Aptian with *G. arborinsularis* Ethridge, 1917 to the Cenomanian with *G. damesi* n.sp..

Infraorder Palinura Latreille, 1803
 Family Palinuridae Latreille, 1802
 Genus *Jasus* Parker, 1883

Jasus sp.
 Fig. 4

Type locality: Hadjula.

Geological age: Cenomanian.

Material: one specimen in a good state of preservation, preserved in part and counterpart.

MSNM: i22859.

The state of preservation of this specimen (total length 4 cm) has allowed only the observation of some morphological features, which are nevertheless not enough for a deeper description. For this reason I prefer not to give a specific ascription. Only the discovery of better preserved specimens will allow to more precisely define what is now limited to a simple report.

However, some morphological features, such as the well developed supraorbital spines, the strong and long rostrum and the squamiform sculputuration on abdominal somites, are the typical features of the living *Jasus* Parker, 1883 (Holthuis, 1991). For this reason the studied specimen is ascribed to this genus.

Jasus Parker, 1883 is known in the fossil record only in the Oligocene of New Zealand with *J. flemingi* Glaessner, 1960 (Glaessner, 1960). At present, this genus consists of seven species living in limited areas in the temperate area of the southern hemisphere (New Zealand, Juan Fernandez Arcipelago, Island Santa Clara, Islands Desventuradas, Southern Africa, Australia, Southern Indian Ocean and Southern Atlantic Ocean) (Holthuis, 1991).

Besides this genus, Garassino (1994) has reported other two genera of palinurids from Hakel and Hadjula outcrops, *Palimurus* sp. and *Linuparus* sp.

Infraorder Anomura H. Milne-Edwards, 1832
 Family Callianassidae Dana, 1852
 Genus *Callianassa* Leach, 1814

Callianassa sp.
 Fig. 5

Type locality: Hadjula.

Geological age: Cenomanian.

Material: one specimen in lateral view, in bad state of preservation and 3 cm in length.

MSNM: i25087.

The morphological features observed in this specimen have not allowed either a careful study or a certain specific ascription.

The ascription to *Callianassa* Leach, 1814 was made possible by the identification of two typical features of this genus: pereopod I widens abruptly to equal propodus, which is rectangular and with short and strong dactylus, and abdominal somites are rudimentary.

On the basis of these observations I think that only the discovery of other better preserved specimens will allow to more clearly define what is now limited to a simple report.

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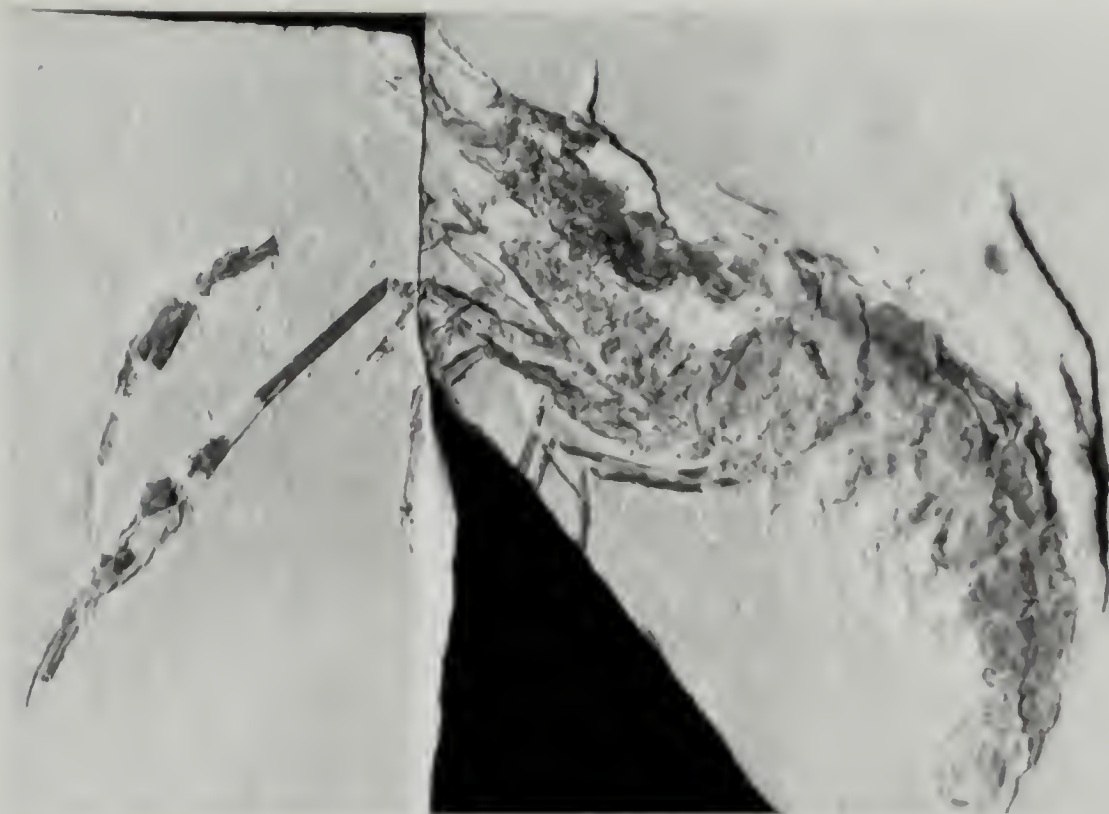


Fig. 2 – *Phoenice pasinii* n.gen.n.sp., holotype, n.cat. MSNM 124799, photo and reconstruction (x0.9).

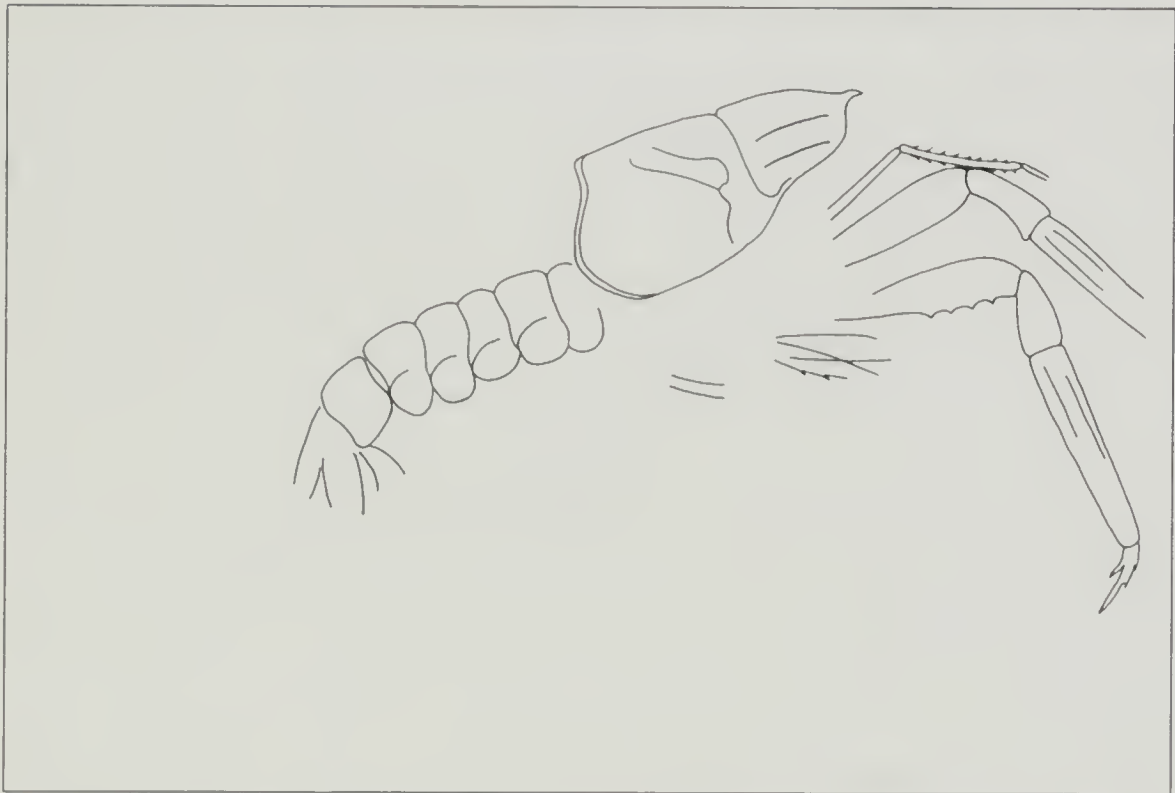


Fig. 3 – *Glyphea damesi* n.sp., holotype, n.cat. MSNM i25122, photo and reconstruction (x2).

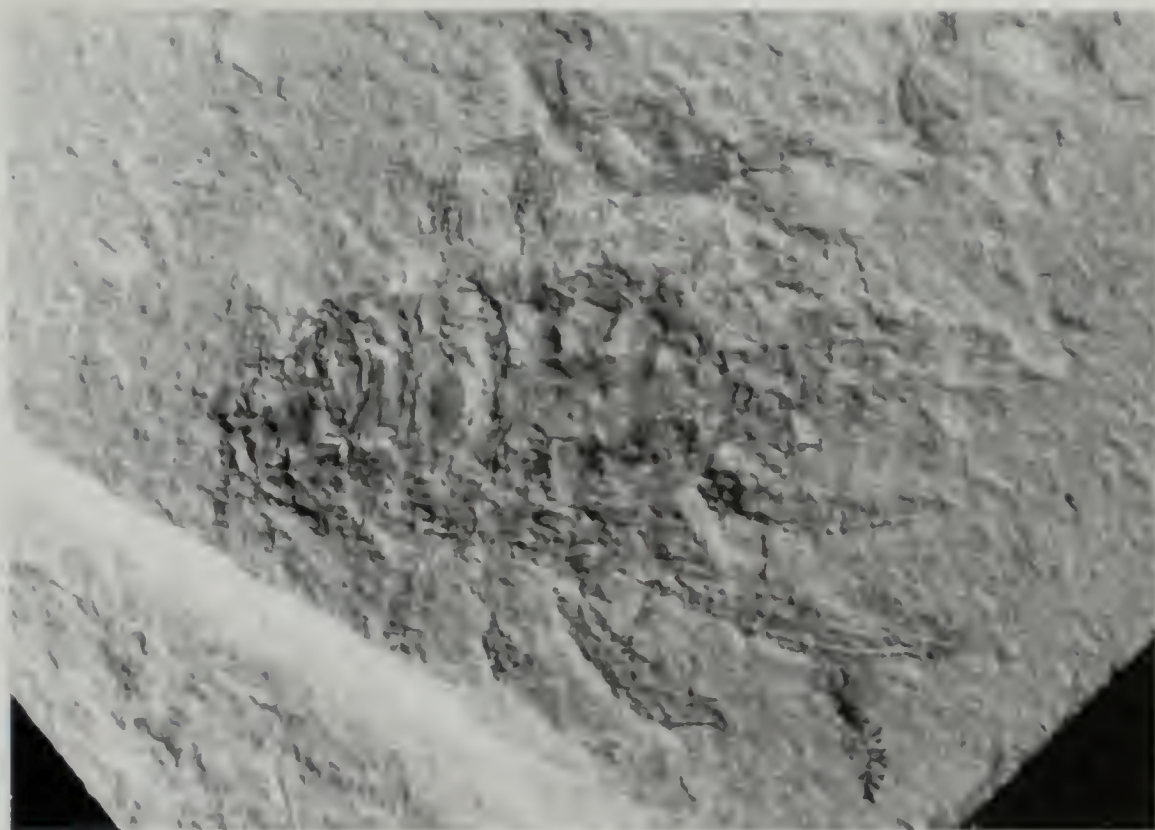


Fig. 4 - *Jasus* sp., n.cat. MSNM 122859, photo and reconstruction (x17).

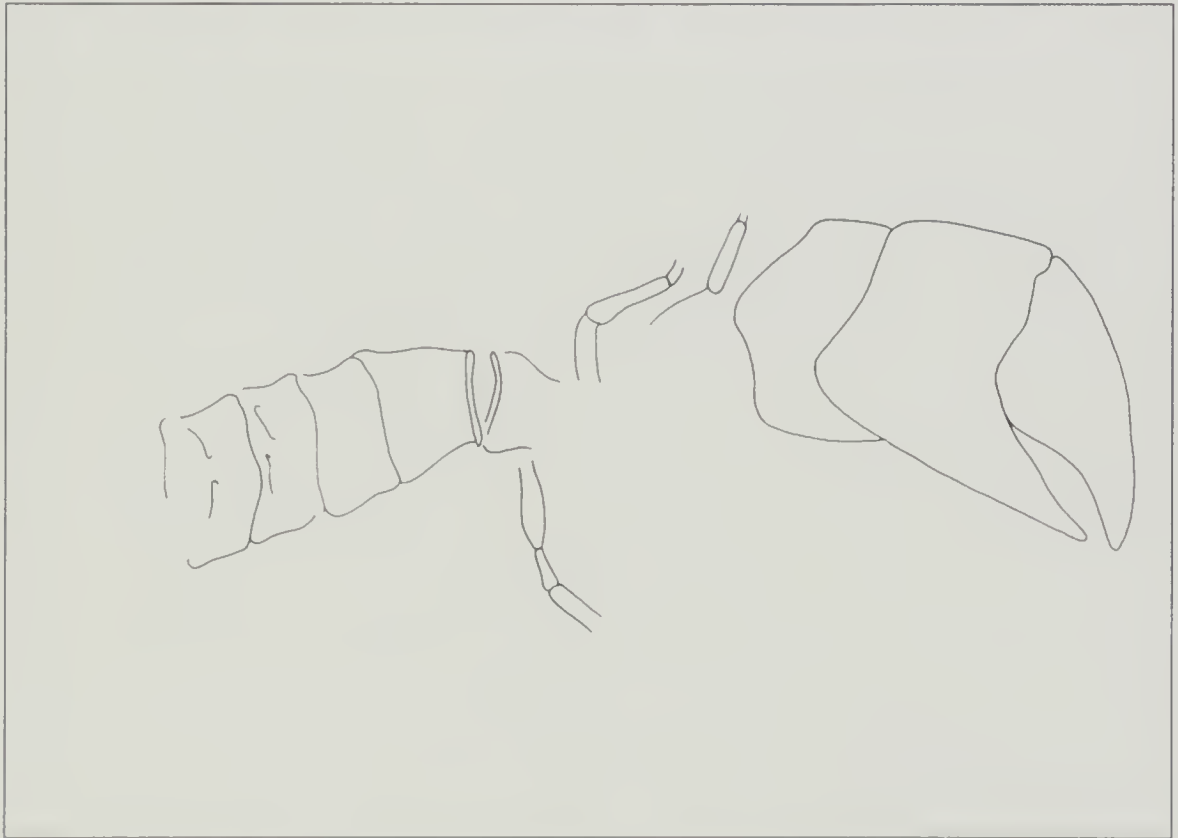
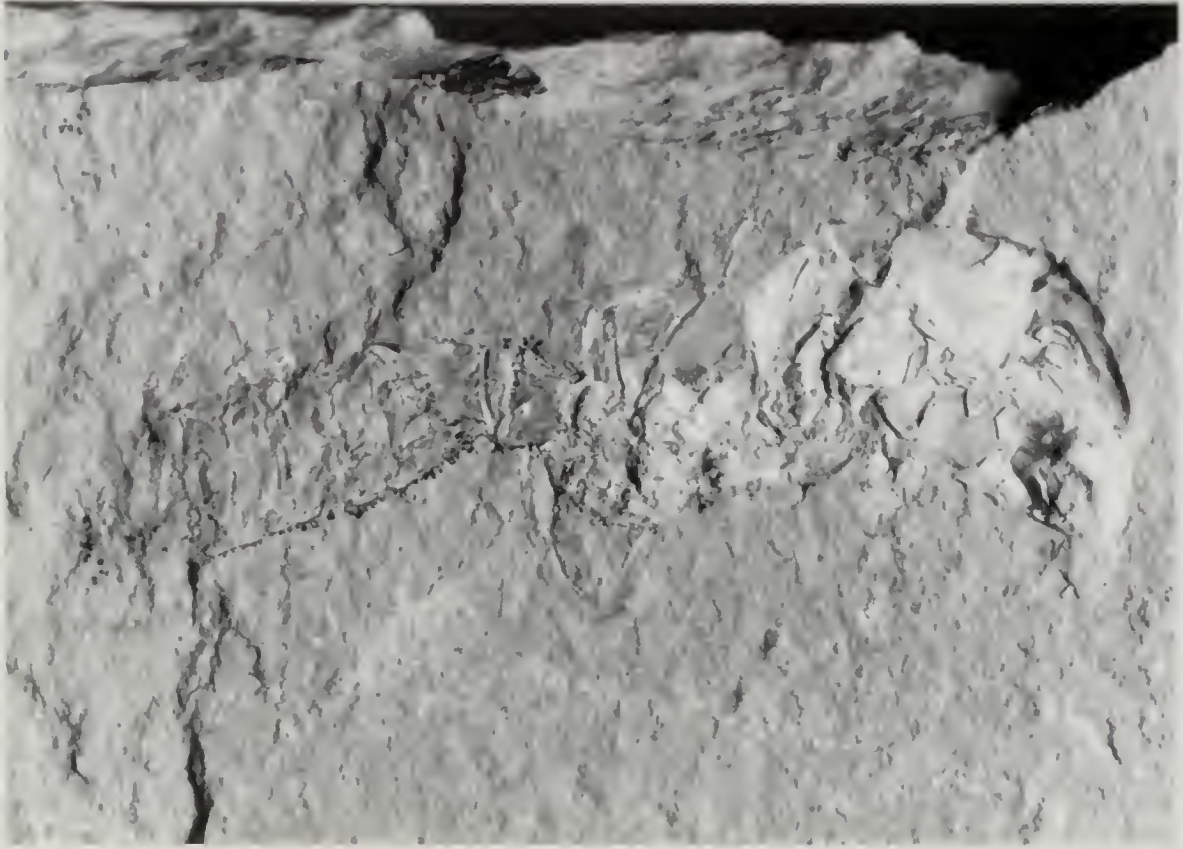


Fig. 5 – *Callianassa* sp., n.cat. MSNM i25087, photo and reconstruction (x2,5).